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PRINCIPAL INVESTIGATOR: Richard A. Shaffer, LCDR, MSC, USN

CONTRACTING ORGANIZATION: Naval Health Research Center
San Diego, California 92186-5122

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Evidence suggests that female military populations are at greater risk than their male counterparts for certain training and combat-related illnesses and injuries. Precise data of the etiologies, risk factors, impact of disease and injury in military women are not available. The objective of this prospective, multisite, epidemiologic study is to define the patterns of illness and injury in military women. Musculoskeletal injuries have been emphasized due to their high cost in terms of morbidity, lost training time, and attrition. A computer-based outpatient tracking system for on-site, prospective data collection, originally designed for studying male trainees, was developed. This system was modified to include medical diagnoses pertinent to female personnel, and it has been implemented at: (1) OCS, Quantico (USMC female officers); (2) MCRD, Parris Island (USMC enlisted women); and (3) NTC, Great Lakes (USN enlisted women). Preliminary analysis reveals that the 3 most common diagnoses at OCS, Quantico, are blisters, ankle sprains, and sinusitis. At NTC, Great Lakes, it is gynecological examinations, upper respiratory infections, and viral syndromes. At MCRD, Parris Island, where only musculoskeletal injuries are recorded, the most common are shin splints, stress fractures, and patella tendinitis. Army and Air Force collaboration has begun to modify and export the software to their female training populations. Study results will be used to address morbidity and attrition issues and to target areas for future preventive interventions.

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FOREWORD

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INTRODUCTION

The scientific knowledge base concerning illness and injury among women in the military is primarily anecdotal. Studies to date describing the patterns of disease and injury in active-duty military populations have dealt almost exclusively with men. Despite evidence that suggests that women use medical facilities more frequently[1] and are at greater risk (relative to men) for certain types of training[1-3] and combat-related[4-7] illnesses and injuries, little has been done to characterize the exact nature and extent of these problems. Precise information on the specific diagnoses and occurrences of illnesses and injuries is necessary to determine the impact on training, attrition, operational readiness, and the overall health and well-being of our female populations. This is particularly critical in light of current efforts to expand the role of women in combat-related missions.

Most of the studies of disease and injury in military women with operational assignments were performed during Operation Desert Storm.[4-8] Although relatively few in number, the studies have suggested that the patterns of disease/injury in women differ from those in men. In one study[6] comparing medical disorders between male and female soldiers, both men and women had high rates of musculoskeletal injuries and minor acute infectious diseases. However, men were more likely to be diagnosed with orthopedic and dermatologic disorders while women were more likely to be diagnosed with psychiatric and optometric problems. Three investigations[4,5,7] showed that women reported symptoms of stress more frequently than their male counterparts, while another showed no significant difference.[8] These studies demonstrate that effective medical and military strategic planning will depend on an accurate quantification of the differential healthcare requirements of male and female military personnel.

In military training populations, epidemiologic studies involving female subjects have focused primarily on musculoskeletal injuries.[1-3,9-12] The data clearly demonstrate that female trainees are at significantly greater risk of incurring a musculoskeletal injury during basic training than are their male

counterparts.[1-3,9-12] At Marine Corps Recruit Depot (MCRD), Parris Island, 45% of female recruits suffer an orthopedic injury compared to 29% of male recruits[2] Similarly, Jones et al. found that U.S. Army female trainees have a much higher incidence of exercise-related injuries than do male trainees, 44.6% compared to 29.0%.[3] Other studies have reported that stress fractures occur up to 12 times more often in female trainees than in male trainees.[11] Stress fractures are a serious overuse injury of bones that require several weeks to several months to rehabilitate. In our recent studies among male recruits at MCRD, San Diego, we have demonstrated a 3-4% stress fracture incidence rate with an estimated annual cost in excess of $12 million.[13] The implications of all these studies in terms of patient morbidity, attrition rates, and training costs for our female military personnel are staggering.

Several studies have indicated that appropriate preventive interventions could significantly reduce the impact of injuries and illnesses in military women in both operational and training communities. Markenson et al. reported that a large proportion of the gynecological resources at Operation Desert Storm's Eight Evacuation Hospitals were used to treat preventable conditions.[14] Another Desert Storm study showed that female veterans with predeployment histories of sexual or physical abuse were more likely to suffer combat-related posttraumatic stress disorder.[4] And finally, several studies involving female military trainees have demonstrated a strong association between risk of musculoskeletal injury during basic training and baseline levels of physical fitness.[1-3,9,14]

Applying solid epidemiological methodology to assessing the impact of morbidity and attrition on training programs is crucial. Epidemiology has been defined as the study of the distribution of a disease or physiological condition in human populations and of factors that influence this distribution.[4] As such, epidemiology traditionally has been concerned with etiologic questions. The definition implies two parts: descriptive and analytic.

In descriptive epidemiology, one addresses issues of the distribution of

a health event. The event may be described using incidence rates, prevalence rates, or the duration of the disease or illness in question. Time trends are also of interest, such as the relationship of morbidity to phase of training. Statistical adjustments can be made for confounding variables.[5]

In contrast, analytic epidemiology is concerned with the determinants of morbidity. Analytic studies depend on data collected specifically for a research project and seldom can rely on routinely available data. Data of this type are almost always observational (as opposed to experimental) in nature; therefore, in attempting to demonstrate an association between a postulated risk factor and a disease outcome, one must be alert to the possibility of confounding the association by other factors. Much of the statistical methodology used in analytic epidemiology is directed at recognizing and correcting confounding; therefore, the methods of analytic epidemiology tend to be more complex than those of descriptive epidemiology. Many sources of bias and imprecision can affect observational epidemiologic data. Control of these adverse effects is achieved through careful choice of study design. Randomized, prospective study designs of cohorts of individuals are among the strongest designs.[5]

A field-tested Naval Health Research Center (NHRC) computer-based outpatient tracking system was recently developed to obtain detailed epidemiologic information required for analytic studies. The researcher and clinician agree in advance upon diagnostic case definitions. The software associated with the system provides complete patient tracking. Data are coded and entered by precise International Classification of Diseases, 9th revision (ICD-9) diagnostic categories. The system allows for prospective data collection beginning at the time of initial evaluation by the clinician. The system has built-in flexibility: new variables of clinical interest can be added and efficiently analyzed at any time. Programming allows the clinician to access the data collected to help solve relevant clinical problems.

A method for systematic collection of outpatient data will be essential for the accurate determination of patterns of disease and injury in female

military populations. The information will quantify the impact of women's health issues on attrition, training costs, and operational readiness. It will target areas for preventive intervention and provide a mechanism to test their effectiveness.

The aim of this integrated project is to apply both epidemiological analytical techniques to answer morbidity and attrition research questions of importance to clinicians serving specific military training populations. Specific objectives include the modification of a computer-based tracking system to include comprehensive medical diagnoses for female Navy and Marine recruits and the determination of rates, etiologies for morbidity, lost training days, and attrition. It is anticipated that the surveillance system will be exported to Air Force and Army female training populations and utilized to collect data and to target areas for future preventive interventions.

METHODS

Study Population

This project is a multisite, prospective, epidemiological study. Data are being collected at four sites and will ultimately include all female recruits in the Navy, Marine Corps, and Air Force. Marine Corps sites include Quantico, where all female officer candidates are trained, and Parris Island, where all female recruits are trained. The Navy site is at Great Lakes, the only Navy boot camp site for men and women as of October 1994. Air Force female recruits will be studied at Lackland Air Force Base. Population at risk is determined by obtaining data from training departments at the various sites. Corrections are made for training programs that send trainees off-site (where trainees, if injured, would not be seen at the clinic doing the data collection). Methods for data collection for incoming Army recruits will be evaluated using information from the initial three sites.

Implementation

Implementation required dedicated computer hardware to support the system, tracking system software, and dedicated data entry personnel at each site. Preliminary activities included individual site visits to determine existing data-gathering capabilities, discuss local needs, install hardware, and to train data-entry personnel. We subsequently modified the interactive computer system software to be site-specific.

Diagnosis is recorded by standard ICD-9 diagnostic coding at patient check-out. Daily logs are printed locally to check on both accuracy and completeness of data entry. All research data are downloaded from remote sites daily via Hayes 9600 baud modems to the NHRC VAX computer. Project data analysts scrutinize this data to ensure completeness and accuracy. If discrepancies arise, they are rectified immediately. These measures are designed to help ensure a high database quality level needed for research purposes.

RESULTS

Application Program

The system is a value-added package, which requires a minimum of a 386 microprocessor and uses the database software Microsoft FoxPro version 2.5 as its platform. The program is divided into two main modules, designated as System and SMART. Each is further divided into six System submodules: Help, System Maintenance, Calculator, Calendar/Diary, Clear, and Quit. SMART system programming staff provide on-line help and technical support.

The Help submodule assists users by providing explanations of commands used in the program. System Maintenance allows production of diskette back-up copies of data and export of data via modem. The SMART program uses the communications software package ProComm Plus and Aspect script language version 2.01 to transfer data. The Calculator and Calendar/Diary submodules are unaltered from FoxPro and remain in the SMART program for personal usage as needed. The Clear submodule clears the screen, and the Quit module executes exit from the SMART program.

The SMART module has five submodules: Daily Update Tasks, Patient Menu, Diagnosis, Reports, and Maintenance. Daily Update Tasks allows a user to maintain current patient information by updating a previously unknown diagnosis to a working or final diagnosis by modifying data entry fields. The Patient Menu options include checking-in and checking-out patients as well as express check-in, which allows a user to save time by initially entering only the patient's social security number (SSN), and adding the remaining information at a more convenient time. Diagnosis, the third submodule, is used to assign diagnoses by ICD-9 codes. For diagnoses of musculoskeletal disorders, this list can be prompted by anatomic location.

The Reports submodule provides routines to perform inquiries, check on data, and produce reports. Reports are available on morbidity for an individual patient or for groups of patients across encounter dates and diagnoses. This submodule also provides a daily log and a provider log, which tally the number of patients seen daily.

The Maintenance submodule allows each clinic to manage listings of its healthcare providers and class schedule.

Variables

Collected variables are recorded in the SMART system. The variables cover a wide range of demographic data, training cycle data, encounter, clinically suspected risk factors, confounding variables, and diagnosis on patients presenting to the clinic. The majority of variables are identical in all four sites. Core variables are noted in Table 1. The ICD-9 codes were further expanded to include comprehensive medical diagnoses for women (Table 2).

Installation

Implementation has been completed at all four sites. We hired dedicated data entry staff at three sites (Parris Island, Great Lakes, and Quantico). This staff was orientated on the research project and trained in using the software. On-site briefs were delivered to research staff and clinic healthcare providers. All patient encounters (injury and general illness) are captured in the surveillance system at Great Lakes and Quantico. At Parris Island, the system is located at the Sports Medicine Clinic and thus captures only musculoskeletal injuries.

The hardware investment at each site was dependent on patient volume of each medical facility and physical layout of the building. Two separate stand-alone systems were required to collect outpatient data from women at Quantico because training for female U.S. Marine Corps Officers occurs at two sites approximately 30 minutes apart. The volume of outpatients seen at the medical facility for recruit training at Naval Training Center (NTC), Great Lakes (20,000 per month), in addition to physical layout of the building, required 8 stand-alone systems to ensure data capture on all outpatient encounters.

Upon installation of each system, documentation of the approval of the purchase of the equipment was provided to the respective information management departments. The system programmer accompanied all hardware for

installation and ensured the successful operation of the software. An NHRC site coordinator trained all personnel at each location on the use and purpose of the system.

We asked the sites to provide a primary operator for each stand-alone system as well as anyone who may have the opportunity to use the system for training. Ninety personnel at the four sites were trained in the proper and complete use of the system. The principal investigator provided on-location training to all clinical providers on the goals and methodology of the system, database development, and the purpose of the project. In addition to the existing Branch Medical Clinic personnel, a full-time research assistant has been hired at NTC, Great Lakes; Marine Corps Base Officer Candidate School (OCS), Quantico; and MCRD, Parris Island. The full-time research personnel act as on-site liaisons for the project, coordinate data collection and data requests, and augment data entry when necessary.

Outpatient Encounter Data

Complete data from Quantico, Great Lakes, and Parris Island were reviewed from 1 April 1995 to 30 June 1995. A total of 2,387 outpatient encounters for new problems was recorded at Great Lakes, 100 encounters at Quantico, and 259 encounters for new musculoskeletal problems at Parris Island. The most common reason for a medical visit among trainees presenting to the Branch Medical Clinic was gynecological exam at Great Lakes (Table 3) and blisters at OCS, Quantico (Table 4). The most common musculoskeletal injury among female trainees presenting to the Branch Medical Clinic was shin splints at Great Lakes (Table 5), ankle sprains at OCS, Quantico (Table 6) and shin splints at Parris Island (Table 7).

CONCLUSIONS

In this prospective, multisite, epidemiologic study of the patterns of illness and injury in military women, emphasis has been placed on musculoskeletal injuries due to their high cost in terms of morbidity, lost training time, and attrition. We developed a computer-based outpatient tracking system for on-site, prospective collection of epidemiologic data in military populations. The system, originally designed for use in studies of male military trainees, has been modified to include comprehensive medical diagnoses pertinent to female military personnel. The modified system has been implemented at three female military training sites: (1) Marine Corps Base OCS, Quantico (USMC female officers; (2) MCRD, Parris Island (USMC enlisted women); and (3) NTC, Great Lakes (USN enlisted women). Preliminary analysis reveals that the three most common diagnoses at OCS, Quantico, are blisters, ankle sprains, and sinusitis. At NTC, Great Lakes, women are most commonly seen for gynecological examinations, upper respiratory infections, and viral syndromes. At MCRD, Parris Island, where only musculoskeletal injuries are recorded, the most common diagnoses are shin splints, stress fractures, and patella tendinitis. Collaboration has begun with Air Force and Army investigators to modify and export the software to their female training populations.

Distinct advantages to carrying out this research on U.S. Navy and Marine Corps personnel at multiple sites include a well-defined population at risk, exceptionally high number of cases, no overlap of data currently available, and direct application of the results. Determination of the population at risk, which is necessary for incidence calculation, is reliably achievable. This standard measure will allow hypothesis testing to be done on intervention research. It also allows for direct comparisons to be made between sites and with other related research findings. A high number of cases translates into timely results, efficient research (both in a statistical and resource sense), and the ability to use stratification and multivariate analysis to control for confounding.

Within the U.S. Navy, Air Force, and Marine Corps outpatient treatment facilities, no comprehensive systems classify illness and injury adequately for epidemiological purposes. For example, monthly morbidity reports contain a column "musculoskeletal" with no further delineation. Such data sources, even if they were to contain more specific diagnostic information, are entirely inadequate for solid, analytical epidemiological research because confounding and suspected etiological variables are not measured. Also, the after-the-fact manner in which these data are collected makes them unsuitable for research purposes. The studies will be conducted on the population to which the results are to be applied. No generalizations from other populations to the Navy, Air Force, and Marine Corps population will be necessary.

To date, numerous research projects on the health and success of women in military training have begun using the ongoing collection of these data from this new system. NTC, Great Lakes, is using data from this system for infectious disease surveillance. A project also is under development to use these data as they are collected to develop policies and standards for the safe and effective training of female U.S. Navy recruits.

The successful completion of the proposed research will aid our understanding of the etiology of illnesses and injuries. In the long term, this understanding will be clinically useful in reducing the morbidity associated with illness and injury among military women. Future intervention studies can be rationally and efficiently planned and executed once the core project components are in place at multiple sites. Results can be used to direct future research.

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Table 1. Core Variables

Demographic

Social security number
First and last name, middle initial
Date of birth
Sex
Race
Branch of military service
Paygrade
Current station
Date reported for duty

Encounter Information

Encounter date
Date data entered
Time checked in and out
Location of treatment facility
Position at facility
Military company/division of patient
Class
Phase of training
Week/day of training

Clinical Variables

ICD-9 code
MMR (morbidity and mortality report)
Visit number
Injury activity
Patient's complaint
Provider name
Provider comments
Disposition
Duty status
Number of disposition days
Preliminary or final diagnosis
Bilateral designation
Multiple diagnoses

Table 2. Female-Specific Diagnoses

626000000	AMENORRHEA
625300000	DYSMENORRHEA
625000000	DYSPAREUNIA
6221A0000	DYSPLASIA OF CERVIX - MILD/CIN I
6221B0000	DYSPLASIA OF CERVIX - MOD/CIN II
6221C0000	DYSPLASIA OF CERVIX - SEVERE/CIN III
621300000	ENDOMETRIAL HYPERPLASIA
617000000	ENDOMETRIOSIS OF CERVIX
V72300000	GYNECOLOGICAL EXAMINATION
626400000	IRREGULAR MENSTRUAL CYCLE
623500000	LEUKORRHEA - NOT SPECIFIED AS INFECTIVE
621600000	MALPOSITION OF UTERUS
626200000	MENOMETRORRHAGIA EXCESSIVE OR FREQUENT MENSTRATION
622700000	MUCOUS POLYP OF CERVIX
620000000	NONINFLAMMATORY DISORDERS OF OVARY, FALLOPIAN TUBE
624800000	OTHER SPECIFIED NONINFLAM. DISORDERS OF VULVA & PERINEUM
V22200000	PREGNANT STATE, INCIDENTAL
625400000	PREMENSTRAL TENSION SYNDROME
626100000	SCANTY OR INFREQUENT MENSTRATION
623300000	TIGHT HYMENAL RING (EXCLUDES IMPERFORATE HYMEN)
131000000	UROGENITAL TRICHOMONIASIS - UNSPECIFIED
625100000	VAGINISMUS
616100000	VAGINITIS & VULVOVAGINITIS, UNSPECIFIED (INCL. GARDNERELLA)

Table 3. Distribution of the Five Most Common Outpatient Illness Diagnoses Among Female Trainees, 1 April 1995 to 30 June 1995, NTC, Great Lakes, IL.

Disorder	Number of cases	Percentage of all encounters for new problems
Gynecological exam	488	20.4%
Upper respiratory infection	283	11.9%
Viral syndrome	76	3.2%
Sinusitis	63	2.6%
Pharyngitis	59	2.5%

Table 4. Distribution of the Five Most Common Outpatient Illness Diagnoses Among Female Trainees, 1 April 1995 to 30 June 1995, OCS, Quantico.

Disorder	Number of cases	Percentage of all encounters for new problems
Blisters (ankle, foot, toes)	12	12.0%
Ankle sprains	8	8.0%
Sinusitis	6	6.0%
Upper respiratory infection	5	5.0%
Knee pain	5	5.0%
Iliotibial Band Syndrome	5	5.0%
Achilles tendinitis/bursitis	5	5.0%

Table 5. Distribution of the Five Most Common Outpatient Musculoskeletal Diagnoses Among Female Trainees, 1 April 1995 to 30 June 1995, NTC, Great Lakes.

Disorder	Number of Cases	Percentage of all encounters for new problems
Shin splints	56	9.8%
Patellofemoral syndrome	54	9.5%
Patellar tendinitis	44	7.7%
Low back pain	34	6.0%
Ankle capsulitis	32	5.6%

Table 6. Distribution of the Five Most Common Outpatient Musculoskeletal Diagnoses Among Female Trainees, 1 April 1995 to 30 June 95, OCS Quantico

Disorder	Number of Cases	Percentage of all encounters for new problems
Ankle sprain	8	17.4%
Knee pain	5	10.9%
Iliotibial Band Syndrome	5	10.9%
Achilles tendinitis/bursitis	5	10.9%
Plantar fasciitis	2	4.3%
Other ankle/foot disorder	2	4.3%
Stress fracture	2	4.3%
Closed fracture	2	4.3%

Table 7. Distribution of the Five Most Common Outpatient Musculoskeletal Diagnoses Among Female Trainees, 1 April 1995 to 30 June 1995, MCRD, Parris Island.

Disorder	Number of Cases	Percentage of all encounters for new problems
Shin splints	28	10.8%
Stress fracture	18	6.9%
Patellar tendinitis	16	6.2%
Ankle/Foot tendinitis	15	5.8%
Patellofemoral syndrome	12	4.6%
Hip adductor strain	12	4.6%
Ankle sprain	12	4.6%
Ankle/Foot/Toes contusion	12	4.6%